(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 821 323 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
26.09.2012 Bulletin 2012/39

(51) Int Cl.:
H01F 1/44 *(2006.01)*

(21) Application number: **06003025.1**

(22) Date of filing: **15.02.2006**

(54) **Preparation method for oil-based magnetic fluid**

Verfahren zur Herstellung eines Ferrofluides auf Ölbasis

Méthode de préparation d'un ferrofluide à base d'huile

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR

(43) Date of publication of application:
22.08.2007 Bulletin 2007/34

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- **PATENT ABSTRACTS OF JAPAN vol. 013, no. 031 (E-707), 24 January 1989 (1989-01-24) & JP 63 232402 A (NIPPON SEIKO KK), 28 September 1988 (1988-09-28)**

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a preparation method for magnetic fluid, especially to oil-based magnetic fluid that absorbs organic material, oil-based material and metal ions inside the fluid. Then by the application of the magnetic field, the absorbed material is separated from the fluid so as to achieve the purposes of fluid treatment or purification.

2. Description of the Related Art

[0002] Magnetic materials have been applied broadly to recording tapes, magnetic materials for memory such as magnetic disks or tapes , building materials such as ink, paint, and mechanical parts such as electromagnetic switches, or seals. By the development of new preparation method, magnetic materials are applied in more fields such as biomedicine for purification of drugs, protein and DNA or environmental waste treatment.

[0003] For example, US patent 4,687,748 applied in 1987 discloses magnetically responsive spheres having an average diameter less than 1 ,000 nm, prepared by dissolving a carbohydrate polymer in a polar solvent and being applied to cell separation as well as affinity purification. Basically, such magnetic separation techniques have two types according to features of material being processed (1) apply the magnetic field to separate material itself with magnetic properties. (2) combine material without magnetic properties with magnetic material by chemical reactions and then apply the magnetic field for separation. In combination of the material without magnetic properties with magnetic material, various types and preparation methods of magnetic material play important roles.

[0004] There are various preparation methods for magnetic material according to users' requirement. The most common is (1) grinding: refer to US patent 4,604,222 , applied in 1986, magnetic fluid is prepared by mixing of magnetic particles, dispersing agent such as a cationic surfactant and organic liquid carrier such as an ester or a glycol and then employing a grinding or ball mill technique so as to improve electrical conductivity and seal computer disc drives.(2) oxidation reaction: such as US patent 6,140,001, applied in 2000, disclosing a method that mix a solution of a soluble phosphate compound such as sodium orthophosphate with a solution of ferrous ion, and alkali or alkaline hydroxide solution to form ferrous hydroxide. Then an oxidation step is performed by passing an oxygen-containing gas through the mixture. Finally, the iron oxide particles of the invention will precipitate from the solution. (3) chemical coprecipitation: refer to US patent 6,743,371, applied in 2004, disclosing magnetic fluid prepared by mixture of magnetic sensitive particles such as nickel-zinc ferrite or manganese-zinc ferrite and conductive particles such as gold, silver, copper, aluminum and graphite. The magnetic fluid is utilized in electrical switching applications. Because the magnetic particles attract each other and thus aggregate, it is necessary to take surface treatment step during preparation process for effectively separation of particles. Not only the diameter of particles is smaller, but the particles are more easily to be dispersed inside the solvent. The ways of surface treatment are different depending on hydrophilic or lipophilic characteristics of the oil-based magnetic fluid being prepared.

[0005] As to the preparation of lipophilic oil-based magnetic fluid, refer to US patent 5,124,060, applied in 1992, a method includes steps of adding the low boiling organic solvent and the dispersant having oleophilic groups to separate particles and heating the resulting material to evaporate the low boiling organic solvent thereby obtaining a magnetic fluid that is applied to seal vacuum apparatus. Moreover, US patent 6,068,785, applied in 2000, disclosing a slurry is formed of particles of a non-magnetic oxide of iron (.alpha.-Fe.sub.2 O.sub.3), an oil carrier liquid and a surfactant. The slurry is then processed in an attrition mill to generate magnetic iron oxide particles for form an oil-based material. Due to direct grinding operation, oil and surfactant may attach on surface of magnetic particles so as to make the surface coating fall off. This leads to negative effect on yield rate.

[0006] US patent 5 135 672 discloses a hydrogen banded tertiary amine - fatty acid complex, mixed with surface coated ferromagnetic particles.

[0007] Generally, magnetic fluid is more applied to magnetic materials for memory and design of mechanical seal. However, it' s seldom used in eliminating organic compounds or oil inside the water and processing metal ions inside the inorganic wastewater. Conventionally, organic wastewater is processed by heat treating or chemically oxidation. This not only costs much but also generates secondary wastewater due to addition of chemicals. As to wastewater with metal ions, besides conventional chemical precipitation, physical treatment methods such as membrane technologies can also be used. Although there is no addition of chemicals, it requires higher equipment cost and more technical support.

[0008] In order to make the oil-based magnetic fluid have lipophilic interface and strong binding force between the magnetic metal oxide particles, the present invention adds surfactant with a carboxyl group during the preparation process of iron oxide so as to generate the magnetic material such as iron oxide with the carboxyl group. Then, the material further reacts with vegetable oil to form oil-based magnetic fluid by crosslinking reaction. The bonding between the magnetic material and the compounds is formed by chemical reaction. Thus the final product has higher bonding force between molecules with better stability.

[0009] Thus the oil-based magnetic fluid in accordance with the present invention can react with oils, organic

compounds, and metal ions inside water and then being separated by the application of magnetic field. The present invention has advantages of no addition of chemicals, simple equipment and easy operation.

SUMMARY OF THE INVENTION

[0010] It is therefore a primary object of the present invention to provide a preparation method for oil-based magnetic fluid that combines magnetic material with vegetable oil by crosslinking reaction of functional groups to form chemical bonds therebetween. By the application of magnetic field, the oil-based magnetic fluid absorbs organic compounds or metal ions for separation from solution. Thus the purposes of fluid treatment or purification are achieved.

[0011] It is another object of the present invention to provide a preparation method for oil-based magnetic fluid. The oil-based magnetic fluid has both magnetism and mobility of fluid. While being mixed with fluid such as wastewater, the oil-based magnetic fluid absorbing organic material and metal ions is immiscible with water. During the process of fluid treatment, there is no need to add catalyst, oxidizing agent or other chemicals. Not only the cost for treatment is saved, but also the recovery process of the catalyst is left out. At the same time, by magnetism, the oil-based magnetic fluid absorbing organic material and metal ions is separated with water rapidly and it' s convenient to operate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The structure and the technical means adopted by the present invention to achieve the above and other objects can be best understood by referring to the following detailed description of the preferred embodiments and the accompanying drawings, wherein

Fig. 1 is a flow chart for preparation of an embodiment of oil-based magnetic fluid in accordance with the present invention;

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0013] Refer to Fig.1, in step S10, a diamino compound is added into vegetable oil to form oil-based compound containing diamino group. Refer to step S12, the oil-based compound having a carboxyl group and a diamino group is obtained by adding carboxyl compounds into the oil-based material containing a diamino group. In step S14, iron solution is mixed with carboxyl compounds to get magnetic iron oxide with a carboxyl group. Refer to step S16, the oil-based compound having a carboxyl group and a diamino group is added into the magnetic iron oxide with a carboxyl group so as to obtain the oil-based magnetic fluid with particles whose diameter ranges from 60 to 100 nanometers.

[0014] In step S10, an embodiment is taking as an example. The compound containing a diamino group such as urea is dissolved into the water. Then add into the same amount of alcohol so as to make the concentration of the urea become 24~30% weight/volume ratio and the mixture is heated inside the reflux condenser at the temperature ranging from 70 to 90 Celsius degrees and 75 Celsius degrees is the preferable temperature. Moreover, take vegetable oil and dilute it with equal volume of ethyl acetate. The diluted oil is dropped into the hot urea solution so as to make the volume ratio between the oil and the urea solution be two. Continuingly heat the resulting mixture for thirty minutes. After the solution cooling down to room temperature, wash it with water and centrifugate the solution to get the raw urea synthetic oil. Repeat the steps of washing and centrifugation several times, the product is urea synthetic oil. That' s oil-based compound with a diamino group.

[0015] Take an embodiment for explanation of step S12. The urea synthetic oil is stirred and heated to 85 Celsius degrees in the reflux condenser. The slowly add the carboxyl compound solution such as undecenoic acid into the urea synthetic oil until the volume ratio of the carboxyl compound solution to the urea synthetic oil becomes 1/5. Continuingly heat the resulting mixture for 30 minutes. Then let it cool down to room temperature, add alcohol into the solution and washing the mixture. After centrifugation, oil-based material having carboxyl group and urea is obtained. The oil-based material having carboxyl group and urea made by condensation reaction between the undecenoic acid and an amino-terminal of the urea is an oil-based compound having a carboxyl group and a diamino group.

[0016] In step S14, ferrous chloride and ferric chloride are dissolved inside deoxidized water and the molecular ratio between them is from 1/2~1/3. The solution is heated to 80 Celsius degrees inside the reflux condenser. Then slowly add the carboxyl compound solution (such as undecenoic acid) about 2.4% volume ratio into the solution and continuingly heat the solution. Take a little amount of 25% ammonia water, diluted with equal amount of alcohol and ethyl acetate and pour into solution inside the reflux condenser. The ammonia water occupies about 20% of the total volume. Keep heating at 80 Celsius degrees for thirty minutes. Then cool down the mixture to 65 Celsius degrees and keeps in this temperature for 5 hours and thirty minutes so as to get the precipitation of magnetic iron powder with a carboxyl group. Magnetically decant clear supernatant, wash the precipitation with alcohol several times and then preserve in a bit alcohol solution. Or after decanting clear supernatant, dry the precipitation at room temperature so as to get the magnetic iron powder with a carboxyl group. That' s magnetic iron oxide coated with a carboxyl group.

[0017] In step S16, add carboxyl urea synthetic oil into magnetic iron powder with a carboxyl group and heat inside the reflux condenser at the temperature from 65 to 80 Celsius degrees for thirty minutes. The temperature

is preferably 85 Celsius degrees.

[0018] After washing with alcohol, water, and separation, the stable oil-based magnetic solution is obtained. The composition of the solution includes iron oxide Fe_3O_4.

[0019] In summary, oil-based magnetic fluid in accordance with the present invention is used in combination with external magnetic field for absorption of floating oil on water surface and separation as well as treatment of organic compounds, metal ions and oil in wastewater.

Claims

1. A preparation method for magnetic fluid comprising the steps of:

   adding a diamino compound into vegetable oil so as to form oil-based compound containing a diamino group;
   adding a carboxyl compound into the oil-based compound containing a diamino group to get a oil-based compound having a carboxyl group and a diamino group;
   mixing iron solution with a carboxyl compound to get a magnetic iron oxide with a carboxyl group; and
   adding the oil-based compound having a carboxyl group and a diamino group into the magnetic iron oxide with a carboxyl group so as to obtain the oil-based magnetic fluid.

2. The method as claimed in claim 1, wherein the diamino compound is urea or one of other compounds containing a diamino group.

3. The method as claimed in claim 1 , wherein the carboxyl compound is undecenoic acid, oleic acid, lauric acid, or caproic acid.

4. The method as claimed in claim 1 , wherein on the step of adding a diamino compound into vegetable oil so as to form oil-based compound containing a diamino group, the diamino compound is urea while the oleaginous material is vegetable oil and the manufacturing method comprising the steps of:

   dissolving the urea into the water, add into the same amount of alcohol and heat the mixture inside the reflux condenser at the temperature ranging from 70 to 90 Celsius degrees;
   taking 50ml vegetable oil, dilute the oil with equal volume of ethyl acetate, dropping diluted oil into the urea solution and heating the resulting mixture for thirty minutes; and
   cooling down the resulting mixture to room temperature, washing with water and
   centrifugating for separation of oil-based compound with a diamino group, which is urea synthetic oil.

5. The method as claimed in claim 4, wherein concentration of the urea ranges from 24% to 30% weight/volume ratio.

6. The method as claimed in claim 4, wherein volume ratio between the vegetable oil and the urea solution is two.

7. The method as claimed in claim 4, wherein the preferable temperature inside the reflux condenser is 75 Celsius degrees.

8. The method as claimed in claim 1, wherein on the step of adding a carboxyl compound into the oil-based compound containing a diamino group to get a oil-based compound having a carboxyl group and a diamino group, the oil-based compound containing a diamino group is urea synthetic oil while the carboxyl compound is undecenoic acid and the step further having the steps of:

   heating the urea synthetic oil to 85 Celsius degrees in the reflux condenser;
   adding into the undecenoic acid and heating the mixture for thirty minutes; and
   cooling down the mixture to room temperature, adding into alcohol, washing with water, centrifugating for separation of oil-based compound having a carboxyl group and a diamino group, which is urea-undecenoic acid synthetic oil.

9. The method as claimed in claim 8, wherein volume ratio of the undecenoic acid to the urea synthetic oil is 1/5.

10. The method as claimed in claim 8, wherein the urea-undecenoic acid synthetic oil is made by condensation reaction between a carboxyl-terminal of the undecenoic acid and an amino-terminal of the urea.

11. The method as claimed in claim 1, wherein on the step of mixing iron solution with a carboxyl compound to get a magnetic iron oxide with a carboxyl group, the carboxyl compound is undecenoic acid and the step further having the steps of:

    dissolving ferrous chloride and ferric chloride inside deoxidized water while the molecular ratio between ferrous chloride and ferric chloride is from 1/2~1/3; heat to 80 Celsius degrees inside the reflux condenser, add into the undecenoic acid continuingly heat resulting solution;
    diluting ammonia water with alcohol and ethyl acetate, pour the dilution into the reflux condenser, and keep heating at 65 to 80 Celsius degrees

for thirty minutes;
cooling down to 65 Celsius degrees to get the precipitation of undecenoic acid-magnetic iron powder; and
decanting clear supernatant to get the undecenoic acid-magnetic iron powder, which is magnetic iron oxide with a carboxyl group.

12. The method as claimed in claim 11, wherein reaction time after adding into the ammonia water ranges from 4 to 6 hours.

13. The method as claimed in claim 11, wherein the preferable temperature inside the reflux condenser is 80 Celsius degrees.

14. The method as claimed in claim 1, wherein on the step of adding the oil-based compound having a carboxyl group and a diamino group into the magnetic iron oxide with a carboxyl group so as to obtain the oil-based magnetic fluid, the oil-based compound having a carboxyl group and a diamino group is urea-undecenoic acid synthetic oil while the magnetic iron oxide with a carboxyl group is undecenoic acid-magnetic iron powder and the step further having the steps of:

adding the undecenoic acid-magnetic iron powder into the urea-undecenoic acid synthetic oil; and
washing with alcohol and water, separating of oil-based magnetic fluid.

15. The method as claimed in claim 1, wherein the mixture of the undecenoic acid-magnetic iron powder with the urea-undecenoic acid synthetic oil is heated at 80 Celsius degrees in the reflux condenser for thirty minutes.

16. The method as claimed in claim 1, wherein the oil-based magnetic fluid includes iron oxide Fe_3O_4.

17. The method as claimed in claim 1, wherein diameter of particles of the oil-based magnetic fluid ranges from 60 to 100 nanometers.

Patentansprüche

1. Verfahren zum Herstellen eines magnetischen Fluids, das die folgenden Stufen aufweist:

Zugeben einer Diaminoverbindung zu einem Pflanzenöl, um eine auf Öl basierende Verbindung zu erzeugen, die eine Diaminogruppe aufweist;
Zugeben einer Carboxylverbindung zu der auf Öl basierenden Verbindung, die eine Diaminogruppe enthält, um eine auf Öl basierende Verbindung mit einer Carboxylgruppe und einer Diaminogruppe zu erhalten;
Mischen einer Eisenlösung mit einer Carboxylverbindung, um ein magnetisches Eisenoxid mit einer Carboxylgruppe zu erhalten; und
Zugeben der auf Öl basierenden Verbindung mit einer Carboxylgruppe und einer Diaminogruppe zu dem magnetischen Eisenoxid mit einer Carboxylgruppe, so daß das auf Öl basierende magnetische Fluid erhalten wird.

2. Verfahren nach Anspruch 1, wobei die Diaminoverbindung Harnstoff oder eine der anderen Verbindungen ist, die eine Diaminogruppe enthält.

3. Verfahren nach Anspruch 1, wobei die Carboxylverbindung Undecansäure, Oleinsäure, Laurinsäure oder Capronsäure ist.

4. Verfahren nach Anspruch 1, wobei beim Schritt des Zugebens einer Diaminoverbindung zum Pflanzenöl, um eine auf Öl basierende Verbindung zu erzeugen, die eine Diaminogruppe enthält, die Diaminoverbindung Harnstoff ist, während das ölige Material Pflanzenöl ist, und wobei das Herstellungsverfahren die folgenden Schritte aufweist:

Lösen von Harnstoff in Wasser, Zugeben der gleichen Menge Alkohol und Erwärmen des Gemischs im Rückflußkondensator bei einer Temperatur im Bereich von 70 bis 90°C;
Aufnehmen von 50 ml Pflanzenöl, Verdünnen des Öls mit dem gleichen Volumen Ethylacetat, Tropfenlassen des verdünnten Öls in die Harnstofflösung und Erwärmen des entstandenen Gemischs für 30 Minuten; und
Abkühlen des entstandenen Gemischs auf Raumtemperatur, Waschen mit Wasser und Zentrifugieren, um die auf Öl basierende Verbindung mit einer Diaminogruppe abzutrennen, die Harnstoff-synthetisches Öl ist.

5. Verfahren nach Anspruch 4, wobei die Konzentration von Harnstoff im Bereich von 24 bis 30 Gew.-% liegt.

6. Verfahren nach Anspruch 4, wobei das Volumenverhältnis zwischen dem Pflanzenöl und der Harnstofflösung 2 beträgt.

7. Verfahren nach Anspruch 4, wobei die bevorzugte Temperatur im Inneren des Rückflußkondensators 75°C beträgt.

8. Verfahren nach Anspruch 1, wobei beim Schritt des Zugebens einer Carboxylverbindung zu der auf Öl basierenden Verbindung, die eine Diaminogruppe

enthält, um eine auf Öl basierende Verbindung mit einer Carboxylgruppe und einer Diaminogruppe zu erhalten, die auf Öl basierende Verbindung, die eine Diaminogruppe enthält, Harnstoff-synthetisches Öl ist, während die Carboxylverbindung Undecansäure ist, und der Schritt ferner die folgenden Stufen aufweist:

Erwärmen des Harnstoffs-synthetischen Öls im Rückflußkondensator auf 85°C;
Zugeben der Undecansäure und Erwärmen des Gemischs für 30 Minuten; und
Abkühlen des Gemischs auf Raumtemperatur, Zugeben von Alkohol, Waschen mit Wasser, Zentrifugieren, um die auf Öl basierende Verbindung mit einer Carboxylgruppe und einer Diaminogruppe abzutrennen, die Harnstoff-Undecansäure-synthetisches Öl ist.

9. Verfahren nach Anspruch 8, wobei das Volumenverhältnis zwischen Undecansäure und Harnstoff-synthetischem Öl 1/5 beträgt.

10. Verfahren nach Anspruch 8, wobei das Harnstoff-Undecansäuresynthetische Öl durch Kondensationsreaktion zwischen einem Carboxylterminus der Undecansäure und einem Aminoterminus des Harnstoffs erzeugt wird.

11. Verfahren nach Anspruch 1, wobei beim Schritt des Mischens der Eisenlösung mit einer Carboxylverbindung, um ein magnetisches Eisenoxid mit einer Carboxylgruppe zu erhalten, die Carboxylverbindung Undecansäure ist, und der Schritt ferner die folgenden Stufen aufweist:

Auflösen von Eisen(II)-chlorid und Eisen (III)-chlorid in desoxidiertem Wasser, wobei das Molverhältnis zwischen Eisen(II)-chlorid und Eisen(III)-chlorid 1/2 ~ 1/3 beträgt; Erwärmen im Rückflußkondensator auf 80°C, Zugeben von Undecensäure, wobei die entstandene Lösung kontinuierlich erwärmt wird;
Verdünnen von Ammoniakwasser mit Alkohol und Ethylacetat, Gießen der Lösung in den Rückflußkondensator und Beibehalten des Erwärmens bei 65 bis 80°C für 30 Minuten;
Abkühlen auf 65°C, um die Fällung von Undecensäure-magnetischem Eisenpulver zu erreichen; und
Dekantieren des klaren Überstands, um die Undecensäure-magnetisches Eisenpulver zu erhalten, das magnetisches Eisenoxid mit einer Carboxylgruppe ist.

12. Verfahren nach Anspruch 11, wobei die Reaktionszeit nach der Zugabe des Ammoniakwassers im Bereich von 4 bis 6 Stunden liegt.

13. Verfahren nach Anspruch 11, wobei die bevorzugte Temperatur im Inneren des Rückflußkondensators 80°C beträgt.

14. Verfahren nach Anspruch 1, wobei beim Schritt des Zugebens der auf Öl basierenden Verbindung mit einer Carboxylgruppe und einer Diaminogruppe in das magnetische Eisenoxid mit einer Carboxylgruppe, um das auf Öl basierende magnetische Fluid zu erhalten, die auf Öl basierende Verbindung mit einer Carboxylgruppe und einer Diaminogruppe Harnstoff-Undecensäure-synthetisches Öl ist, während das magnetische Eisenoxid mit einer Carboxylgruppe Undecensäure-magnetisches Eisenpulver ist und der Schritt ferner folgende Stufen aufweist:

Zugeben von Undecensäure-magnetischem Eisenpulver in Harnstoff-Undecensäure-synthetisches Öl; und
Waschen mit Alkohol und Wasser, Abtrennen des auf Öl basierenden magnetischen Fluids.

15. Verfahren nach Anspruch 1, wobei das Gemisch von Undecensäure-magnetischem Eisenpulver und Harnstoff-Undecensäuresynthetischem Öl im Rückflußkondensator für 30 Minuten bei 80°C erwärmt wird.

16. Verfahren nach Anspruch 1, wobei das auf Öl basierende magnetische Fluid Eisenoxid Fe_3O_4 einschließt.

17. Verfahren nach Anspruch 1, wobei der Partikeldurchmesser des auf Öl basierenden magnetischen Fluids im Bereich von 60 bis 100 nm liegt.

Revendications

1. Procédé de préparation d'un fluide magnétique comprenant les étapes consistant à :

ajouter un composé diamine dans une huile végétale pour former un composé à base d'huile contenant un groupe diamine ;
ajouter un composé carboxyle dans le composé à base d'huile contenant un groupe diamine pour obtenir un composé à base d'huile présentant un groupe carboxyle et un groupe diamine ;
mélanger une solution de fer avec un composé carboxyle pour obtenir un oxyde de fer magnétique avec un groupe carboxyle ; et
ajouter le composé à base d'huile présentant un groupe carboxyle et un groupe diamine dans l'oxyde de fer magnétique avec un groupe carboxyle afin d'obtenir le fluide magnétique à base d'huile.

2. Procédé selon la revendication 1, dans lequel le composé diamine est l'urée ou l'un parmi d'autres composés contenant un groupe diamine.

3. Procédé selon la revendication 1, dans lequel le composé carboxyle est l'acide undécénoïque, l'acide oléique, l'acide laurique ou l'acide caproïque.

4. Procédé selon la revendication 1, dans lequel dans l'étape consistant à ajouter un composé diamine dans une huile végétale afin de former un composé à base d'huile contenant un groupe diamine, le composé diamine est l'urée tandis que le matériau oléagineux est une huile végétale et le procédé de fabrication comprend les étapes consistant à :

dissoudre l'urée dans de l'eau, ajouter la même quantité d'alcool et chauffer le mélange à l'intérieur d'un condenseur à reflux, à une température comprise entre 70 et 90 degrés Celsius ;
prendre 50 ml d'huile végétale, diluer l'huile dans le même volume d'acétate d'éthyle, laisser tomber l'huile diluée dans la solution d'urée et chauffer le mélange résultant pendant trente minutes ; et
refroidir le mélange résultant à la température ambiante, laver à l'eau et centrifuger afin de réaliser une séparation du composé à base d'huile avec un groupe diamine, qui est une huile synthétique à base d'urée.

5. Procédé selon la revendication 4, dans lequel la concentration de l'urée se situe dans une plage de rapport poids/volume comprise entre 24 % et 30 %.

6. Procédé selon la revendication 4, dans lequel le rapport de volume entre l'huile végétale et la solution d'urée est égal à deux.

7. Procédé selon la revendication 4, dans lequel la température préférable à l'intérieur du condenseur à reflux est égale à 75 degrés Celsius.

8. Procédé selon la revendication 1, dans lequel dans l'étape consistant à ajouter un composé carboxyle dans le composé à base d'huile contenant un groupe diamine afin d'obtenir un composé à base d'huile présentant un groupe carboxyle et un groupe diamine, le composé à base d'huile contenant un groupe diamine est une huile synthétique à base d'urée tandis que le composé carboxyle est l'acide undécénoïque et l'étape comprend en outre les étapes consistant à :

chauffer l'huile synthétique à base d'urée à 85 degrés Celsius dans le condenseur à reflux ;
ajouter dans l'acide undécénoïque et chauffer le mélange pendant trente minutes ; et
refroidir le mélange à la température ambiante, ajouter dans l'alcool, laver à l'eau, et centrifuger afin de réaliser une séparation du composé à base d'huile présentant un groupe carboxyle et un groupe diamine, qui est une huile synthétique à base d'acide undécénoïque et d'urée.

9. Procédé selon la revendication 8, dans lequel le rapport de volume de l'acide undécénoïque sur l'huile synthétique à base d'urée est égal à 1/5.

10. Procédé selon la revendication 8, dans lequel l'huile synthétique à base d'acide undécénoïque et d'urée est obtenue par une réaction de condensation entre un carboxyl-terminal de l'acide undécénoïque et un amino-terminal de l'urée.

11. Procédé selon la revendication 1, dans lequel dans l'étape consistant à mélanger une solution de fer avec un composé carboxyle afin d'obtenir un oxyde de fer magnétique avec un groupe carboxyle, le composé carboxyle est l'acide undécénoïque et l'étape comprend en outre les étapes consistant à :

dissoudre du chlorure ferreux et du chlorure ferrique dans de l'eau désoxydée tandis que le rapport moléculaire entre le chlorure ferreux et le chlorure ferrique est compris entre 1/2 et 1/3 ;
chauffer à 80 degrés Celsius à l'intérieur du condenseur à reflux, ajouter dans l'acide undécénoïque en continuant à chauffer la solution résultante ;
diluer de l'ammoniaque avec de l'alcool et de l'acétate d'éthyle, verser la dilution dans le condenseur à reflux et maintenir le chauffage entre 65 et 80 degrés Celsius pendant trente minutes ;
refroidir à 65 degrés Celsius afin d'obtenir une précipitation de poudre de fer magnétique-d'acide undécénoïque ; et
décanter le surnageant clair afin d'obtenir la poudre de fer magnétique-d'acide undécénoïque, qui est un oxyde de fer magnétique avec un groupe carboxyle.

12. Procédé selon la revendication 11, dans lequel la durée de la réaction après l'ajout dans l'ammoniaque est comprise entre 4 et 6 heures.

13. Procédé selon la revendication 11, dans lequel la température préférable à l'intérieur du condenseur à reflux est égale à 80 degrés Celsius.

14. Procédé selon la revendication 1, dans lequel dans l'étape consistant à ajouter le composé à base d'huile présentant un groupe carboxyle et un groupe diamine dans l'oxyde de fer magnétique avec un groupe carboxyle afin d'obtenir le fluide magnétique à base d'huile, le composé à base d'huile présentant un

groupe carboxyle et un groupe diamine est une huile synthétique à base d'acide undécénoïque et d'urée tandis que l'oxyde de fer magnétique avec un groupe carboxyle est une poudre de fer magnétique-d'acide undécénoïque et l'étape comprend en outre les étapes consistant à :

ajouter la poudre de fer magnétique-d'acide undécénoïque dans l'huile synthétique à base d'acide undécénoïque et d'urée ; et
laver avec de l'alcool et de l'eau, séparer le fluide magnétique à base d'huile.

15. Procédé selon la revendication 1, dans lequel le mélange de la poudre de fer magnétique-d'acide undécénoïque avec l'huile synthétique à base d'acide undécénoïque et d'urée, est chauffé à 80 degrés Celsius dans le condenseur à reflux pendant trente minutes.

16. Procédé selon la revendication 1, dans lequel le fluide magnétique à base d'huile comprend de l'oxyde de fer Fe_3O_4.

17. Procédé selon la revendication 1, dans lequel le diamètre des particules du fluide magnétique à base d'huile est compris entre 60 et 100 nanomètres.

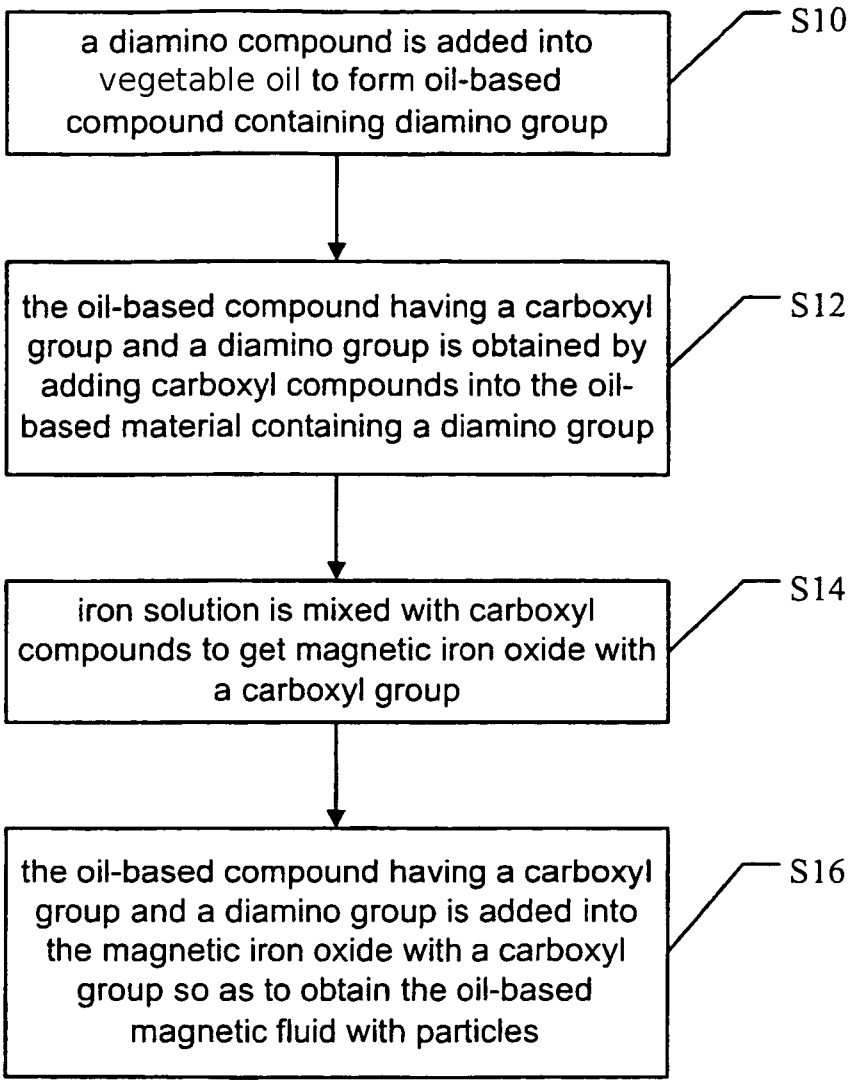
a diamino compound is added into vegetable oil to form oil-based compound containing diamino group
S10
the oil-based compound having a carboxyl group and a diamino group is obtained by adding carboxyl compounds into the oil-based material containing a diamino group
S12
iron solution is mixed with carboxyl compounds to get magnetic iron oxide with a carboxyl group
S14
the oil-based compound having a carboxyl group and a diamino group is added into the magnetic iron oxide with a carboxyl group so as to obtain the oil-based magnetic fluid with particles
S16

Fig. 1

REFERENCES CITED IN THE DESCRIPTION

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